Bonding characteristics of glass seal/metallic interconnect for SOFC applications: Comparative study on chemical and mechanical properties of the interface

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**Introduction:**
Glass and glass-ceramics have been extensively used as seal material in planar solid oxide fuel cell (SOFC) stacks. The main objective of the present work was to investigate the joining properties of a silica-based glass-ceramic seal material with two different ferritic stainless steels as interconnects (i.e., SS430 and Crofer 22APU).

For a straightforward approach to evaluate sealing materials, sandwiched samples will allow interface strength measurements and macroscopic overview on the interfacial situation of a glass-ceramic material. A convenient method for determining the interfacial fracture energies is double cantilever beam (DCB) test. The method allows to measure the crack-growth resistance of these materials to be able to use fracture mechanics design methods. Stable crack growth is necessary to get reliable and unambiguous fracture toughness data. If the fracture toughness values are determined from test configurations that do not allow stable crack growth, then the measurement may be invalid to crack initiation than crack growth. In such cases, the calculated value of the fracture toughness may depend on the geometry of the crack length.

**Tasks:**
- A glass was synthesized with the nominal composition of 20-50 mol%SiO2, 0-10 mol%B2O3, 5-15 mol%Al2O3, 25-50 mol%SrO, 0-25 mol%CaO, and 3 mol% (8.16 wt.%) Y2O3.
- Joint samples of metal/glass/metal were prepared at 850°C for 0.5 h under air and then cooled down to 800°C and aged for 100 h.
- Chemical characterization was conducted on glass/ceramic interfaces by SEM-EDS.
- Mechanical characterization was conducted by double cantilever beam (DCB) and nano-indentation testing (NIT) methods.

**Aims:**
- Correlating between chemical and mechanical properties of seal/interconnect interfaces is the main topic of this research.

**Fabrication of large sandwich samples of metal/glass/metal for macro-mechanical testing:**
Sandwich samples are joined and aged at 800°C in the furnace and glued between two steel beams for macro-mechanical testing.

**Fabrication of small sandwich samples of metal/glass/metal for microscopy and nano-mechanical testing:**
Small gaps were introduced in the sandwich sample to direct the crack to the interface.

**Summary:**
- A technique for evaluating the critical energy-release rate/fracture toughness of this glass-ceramic layers and stainless steel metal strips is described.
- The approach involves a new specimen geometry, in which a sandwich sample is glued onto thicker steel beams.
- The advantages of the technique, static crack growth, allows fracture energy and toughness of a desired joint materials to be evaluated.
- The fracture toughness for crack initiation was measured with a very good reproducibility.

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**References:**